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Bioecological survey of weevils damaging fruit crops in Reunion Island

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Abstract. **Various species of phyllophagous weevils, mainly in the genus *Cratopus* (Curculionidae, Brachyderinae, Cratopini) are associated with numerous wild or cultivated host plants in Reunion Island. On some fruit crops, the adults sometimes induce severe defoliations. In 1989-90, a bioecological survey was conducted on the main fruit crops in the whole island, in order to precise the identification of species within this complex, to determine their distribution and relative importance and to evaluate the level of damages. Results indicated that numerous species were present, among which *C. humeralis* appears by far the most abundant in most areas of the island. Locally, or on particular host-plants, other species may also be important : *C. angustatus* and *Pantomorus cervinus*. The highest levels of damages were caused by *C. humeralis*, mainly on Citrus, in areas of medium altitudes (600-800 m).**

Introduction

Together with Mauritius and Rodrigues, Reunion Island belongs to the Mascarenes archipelago in the south-western part of Indian Ocean. This mountainous volcanic island covers 2512 km^2 and presents a tropical climate, largely influenced by altitude and prevailing winds. The austral summer, from december to april, is the rainy season during which typhoons may occur, whereas the austral winter, from may to november, is drier and cooler.

Though the major part of the useful land (66 p. cent) is devoted to sugarcane, fruit crops have developped strongly during the last 15 years, reaching a total acreage of some 5000 ha, due to recent emphasis on cultural diversification. The production of tropical fruits, (mainly litchi, mango and citrus) is the most important but temperate fruits (peach, apple) are also grown at medium and high altitude.

Among various pest problems on these crops, damages caused by some phyllophagous adult weevils (*Cratopus* spp.) were frequently observed on different fruit species. As very little was known about the bioecology of this group of pests in the island a first study was initiated by CIRAD/IRFA in 1989-90, in order to precise the species involved and their relative importance on the main fruit crops.

Hustache (1920), who first studied in detail the taxonony of the group, described 65 species in the genus *Cratopus* (Curculionidae, Brachyderinae, Cratopini) in the Seychelles, Madagascar and

mainly in the Mascarenes (32 species in Reunion Island). Vinson (1967) considered this genus to be endemic to the Mascarenes because of the specific diversity : on 64 species, he recorded 42 in Mauritius, 32 in Reunion and 5 in Rodrigues, a few species extending their distribution area to Madagascar and neighbouring islands : Comoros, Europa, Aldabra, Glorieuses, Seychelles and Tromelin (Table 1). According to Hustache (1920), the genus is also found in India where it is represented by 3 species, one of which (*C. adspersus* Waterhouse) is also present in the Seychelles.

On the 32 species from Reunion, 16 are recorded as endemic of the island, while the others are also found in Mauritius, or sometimes in Madagascar or Comoros (Vinson, 1967). However, in a survey conducted in Reunion in 1957, Richard only found 16 species among those recorded by Hustache (1920), most of them present in the highlands while 5 also in the lowlands : *C. somptuosus* Boheman, *C. scapularis* Deyrolle, *C. aeneoniger* Hustache, *C. humeralis* Boheman. and *C. punctum* F.

Previous biological data on this group were very scarce. Adults are known to cause sometimes important damages, caracterised by narrow, deep leaf-eating. Though these damages are most frequent on some fruit crops, the host-range of some species seem to be very large, and Hustache (1920) mentions *C. punctum* to be common on nearly all cultivated plants, particularly on roses. Richard (1957) also noticed the wide polyphagy of *C. humeralis* found on egg-plant, eucalyptus, Casuarina, sugarcane, peach, apple... Plenet (1965) recorded damages of *C. ditissimus* Boheman and *C. herbaceus* (a single species, according to Hustache) on potato, of *C. bouroni* Hustache on peach and of *Cratopus* spp. on geranium, vine and avocado. On citrus, Etienne et Vilardebo (1978) mention damages caused by five species : *C. frappieri* Deyrolle, *C. humeralis*, *C. scapularis*, *C. somptuosus* and *C. angustatus* Boheman, this latter species being sometimes responsible of heavy defoliation mainly in the highlands.

As to preimaginal instars, Hustache (1920) indicates that larvae and nymphs of the common species *C. punctum* can sometimes be found in high numbers in sugarcane fields, in the soil covered by old leaves. This author also mentions the nocturnal habits of the adults.

Some questions remain about the taxonomic study of this genus, in which some related species appear very difficult to be distinguished following Hustache's descriptions. For instance, it seems surprising that the common *C. punctum* mentionned by Hustache (1920) and Richard (1957) in various localities was never found in the more recent prospections. Further taxonomic and biological studies would be useful to clarify such points. During our studies, a large part of the collected material was sent to Mr R. Richard that we acknowledge here sincerely.

Material and methods

This survey was conducted from september 1989 to january 1990, in 22 plots, distributed in various parts of the island, covering a large range of altitudes and the most important susceptible fruit crops (citrus, litchi, peach, apple...). In most cases, data were collected monthly on each plot. At times, some additionnal plots were also ponctually visited.

To evaluate the diversity and abundance of the species, branches were shaked over an umbrella. The method seemed suitable as the adults tend to fall down readily when disturbed. The sampling unit consisted of twenty samples (two samples per tree on 10 randomly selected trees, or one per tree on 20 trees for young orchards).

Damages on leaves were evaluated on each sampled tree according to the following scale :

0 : no damage
1 : less than 50 p. cent of the leaves with symptoms
2 : more than 50 p. cent of the leaves with symptoms
3 : a large majority of the leaves with heavy symptoms

Except for young trees, each tree was rated twice by observing two faces. A mean damage rating was then calculated for the whole plot.

When possible, weevils vere also collected on windbreaks, or adjacent crops or vegetation. Notes were also taken on the type of weed control and spraying practices.

Results and discussion

The species and their distribution areas

Eight *Cratopus* species were found during the survey : *C. humeralis*, *C. angustatus*, *C. parvus* Deyrolle, *C. frappieri*, *C. somptuosus*, *C. exquisitus*, *C. sandi* Deyrolle and *C.* near *circumcinctus* (new species). *C. brunnipes* Fabricius, which closely ressembles *C. angustatus*, has not been separated from this species in our survey.

Another species was found damaging bananas on the lowlands of the East : it had been previously discovered and was recently described as *C. bernei* (Richard, pers. com.)

Two wingless species of related genera were also collected :

- *Pantomorus cervinus* Boheman : this american species, largely polyphagous, extended its distribution to Europe, North Africa and Australia. Though it hadn't been previously mentionned from Reunion, we collected it frequently at various altitudes.
- *Cratopopsis bistigma* was only collected at high altitudes (Plaine des Cafres) on peach and *Solanum auriculatum* Ait.

The distribution maps of the species (Fig. 1 a and b) show an increase of the specific diversity with altitude. For instance, at medium and high altitudes (above 600 m in the South and 800 m in the West), the common *C.humeralis* is collected, but also *C. angustatus*, *P. cervinus*, *C. frappieri*, *C. somptuosus* and *C. parvus*. The ecological requirements of the most frequently collected species have been roughly estimated according to the main climatic factors and the ecologic zones of the island as defined by Cadet (1980).

C. humeralis appears by far the most common and widespread species. It seems adapted to a wide range of ecological situations and altitudes, though it prefers the lee-ward side of the island.

The distribution area of *C. angustatus* and *C. parvus* seems to fit rather well the ecological zone C as defined by Cadet (1980), characterized by a medium level of winter rainfall. These species

seems to tolerate the high rainfall of the wind-ward side of the island.

P. cervinus has a larger distribution area, in the ecological zones B and C , and could perhaps tolerate a lower level of winter rains. An excess of rainfall seems to affect this species which has not been found when the annual rainfall exceeds 3 m. Its distribution is apparently little influenced by temperature.

The other species appears far less important and are restricted to the highlands.

Relative importance

It has been estimated by the ratio of each species in the total catches for a particular plot. This confirms that *C. humeralis* is by far the most common species, found in nearly all the localities on all the fruit crops prospected (Fig. 2), except in the lowlands of the East, on litchi. In this case, *C. humeralis* is replaced by *C. angustatus* that seems more adapted to the high rainfall of this area. However, in other areas (i.e. Petite Ile, in the South), *C. humeralis* may be the dominant species on litchi. In certain instances, *P. cervinus* may be more important, as in a citrus orchard of Salazie where it was the only species collected.

Evolution of abundance and damage

The results are summarized in Table 2 and 3. In most cases, we observed an increase in the abundance of adult weevils (all species together) collected during november and december, maybe related to the occurence of austral summer rains. During this last month, adult weevils were present in 96 p. cent of the plots with an abundance (A) above 50 adults per sampling unit in 20 p. cent of them.

The characteristics of the eight plots where high populations were detected (A>50) can be summarized as follows :

- in October/November :	on peach (1350 m)	Centre	100>A>50
	on Citrus (600 m)	South	A>100
	on Citrus (640 m)	South	A>100
- in November/December :	on peach (1000 m)	North	100>A>50
	on Citrus (850 m)	South	100>A>50
	on peach (1350 m)	Centre	A>100
	on apple (1350 m)	Centre	A>100

Globally, the highest populations were observed in the Centre and the South (A>100) and also in the West (100>A>50), generally above 800 m (600 m in the South). The increase in abundance seemed to occur a little bit earlier in the South, compared with the Centre and the West.

The highest number of plots with a mean damage rating above 2 was observed in october - november. Whatever the period, heavy damages were observed mainly on citrus, in plots situated at altitudes between 600 m and 800 m.

In these areas, only *C. humeralis* and *P. cervinus* were present, the other species being generally found at higher elevations. These two species can be considered as the most damaging ones.

The species and variety of the host-plant appears important. The prefered species seem to be apple, loquat and above all citrus, particularly oranges. For instance, in a citrus orchard of the North-West (600 m), the Hamlin orange plot was heavily attacked while adjacent lime and clementine plots weren't much affected.

The environment of the orchard also seems to play a prominent role. In the apple plot where heavy damages were observed in september - october, an important source of weevils was represented by near-by loquats with numerous flushes. Damages were observed on various common hosts whether herbaceous plants (*Amaranthus* sp.) or shrubs (*Rubus alceaefolius*, *Solanum auriculatum*, *Lantana camara*, *Schinus terebinthifolius*, *Leucaena leucocephala*, *Syzigium jambos*...). The geranium, which represents an important crop for the highlands of the West, is also frequently attacked and may constitute a reservoir for the pest. The proximity of sugarcane fields where the larvae could develop may also contribute to increase the infestation, but this has to be confirmed by further studies.

Other factors seem to influence the weevil populations and damages, such as :

- the type of weed control : high populations seemed to be more frequent when weeds were abundant
- the phenology of host-plant : in many cases, high levels of population and damages were correlated with a flushing period, particularly on citrus and loquat.

Conclusion

This preliminary survey constitutes a first step towards a better understanding of the problem of phyllophagous weevils of fruit crops in Reunion Island.

Further studies should concentrate on the assessment of the real economic impact of such pests, on the biology of the most important species, *C. humeralis* and on its population dynamics over a longer period, taking into account the preimaginal instars. This knowledge should allow an improvement of control methods currently often based on a few applications of broad-spectrum insecticides.

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TABLE 1 - GEOGRAPHICAL DISTRIBUTION OF CRATOPUS SPP.
(from HUSTACHE, 1920 ; VINSON, 1967)

ESPECES	1	2	3	4	5	6	7
C. adspersus WATERH.		•		•			•
C. aeneoniger HUST.	•	•					
C. alboscutellatus BOH.	•						
C. anceps MARSHALL		•					
C. angustatus BOH.	•	•					
C. antelmei HUST.		•					
C. armatus HUST.		•					
C. arquatus HUST.		•					
C. aurostriatus FAIRM.				•	•?		
C. bouroni HUST.	•						
C. brunnipes FABR.	•	•					
C. caliginosus BOH.	•	•					
C. carlei HUST.		•					
C. chrysochlorus BOH.	•	•					
C. circumcinctus BOH.	•						
C. confusus BOH.		•					
C. convexicollis HUST.	•					•	
C. denudatus FAIRM.							
C. desjardinsi FAIRM.		•					
C. ditissimus BOH.	•				•	•	
C. exquisitus BOH.	•						
C. fasciger MSHL		•					
C. flavomaculatus MSHL		•					
C. frappleri DEYROLLE	•						
C. fulvescens BOH.	•						
C. griseovestitus LINNELL				•			
C. griseoviridis HUST.	•	•					
C. hamatipes MSHL		•					
C. humeralis BOH.	•	•					
C. ictericus BOH.	•						
C. inornatus WATERH.			•				
C. lateralis HUST.		•					
C. leucophaetus BOH.	•				•		
C. lotus BOH.	•						
C. magnificus WATERH.			•				
C. marginatus BOH.	•						
C. marmoreus BOH.	•	•			•		
C. melanocephalus FABR.		•					
C. molitor BOH.		•					
C. moreli DEYROLLE	•						
C. murinus BOH.	•	•					
C. muticus CHAMP.				•			
C. nanus BOH.	•						
C. nigrogranatus FAIRM.		•					
C. nubilosus MSHL		•					
C. ovalis HUST.		•					
C. parvus DEYROLLE	•						
C. perturbatus BOH.		•					
C. pilosus HUST.		•					
C. psittacus FAIRM.		•					
C. punctum FABR.		•					
C. rocki HUST.	•	•					
C. roralis FABR.			•				
C. roseus HUST.		•					
C. sandi DEYROLLE		•					
C. sanguinicollis OL.	•						
C. scapularis DEYROLLE	•	•					
C. segregatus CHAMP.				•		•	
C. septemvittatus DEYROLLE	•						
C. somptuosus BOH.	•	•					
C. striga FABR.		•					
C. tigratus HUST.		•					
C. triangularis BOH.		•					
C. tristis HUST.	•	•					
C. variegatus HUST.		•					
C. virescens WATERH.			•				
C. viridilimbatus HUST.	•	•					
C. viridipunctatus MSHL			•				
C. viridisparsus FAIRM.						•	
C. viridulus HUST.		•					

1 : Reunion ; 2 : Maurice ; 3 : Rodrigues ; 4 : Seychelles ;
5 : Madagascar ; 6 : Comores ; 7 : Inde (Iles Maldives).

N.B. : endemic species of Reunion Island are underlined.

Table 2 - Abundance of adult weevils during the survey
(Abundance = A = adult weevils/sampling unit)

period	Visited plots (#)	Contamin. plots (#)	Plots (#) for each abundance class A<10	10<A<50	50<A<100	A>100
Sept.-Oct.	29	19 (65.5%)	16	3		
Oct.-Nov.	28	23 (82.1%)	11	9	1	2
Nov.-Dec	26	25 (96.1%)	6	13	3	2

Table 3 - Characteristics of the plots showing a high mean leaf damage rating during the survey

Period	Plots (#) with damage rating >2	Characteristics of the plots
Sept.-Oct.	2 (6.9%)	Citrus (720 m)-S.W.
Oct.-Nov.	6 (21.4%)	Citrus (600 m)-N.+ S. Citrus (640 m)-S. Citrus (720 m)-S.W. loquat (600 m)-S. apple (600 m)-S.
Nov.-Dec.	3 (11.5%)	Citrus (600 m)-N.W. Citrus (720 m)-S.W. geranium (1000 m)-N.W.

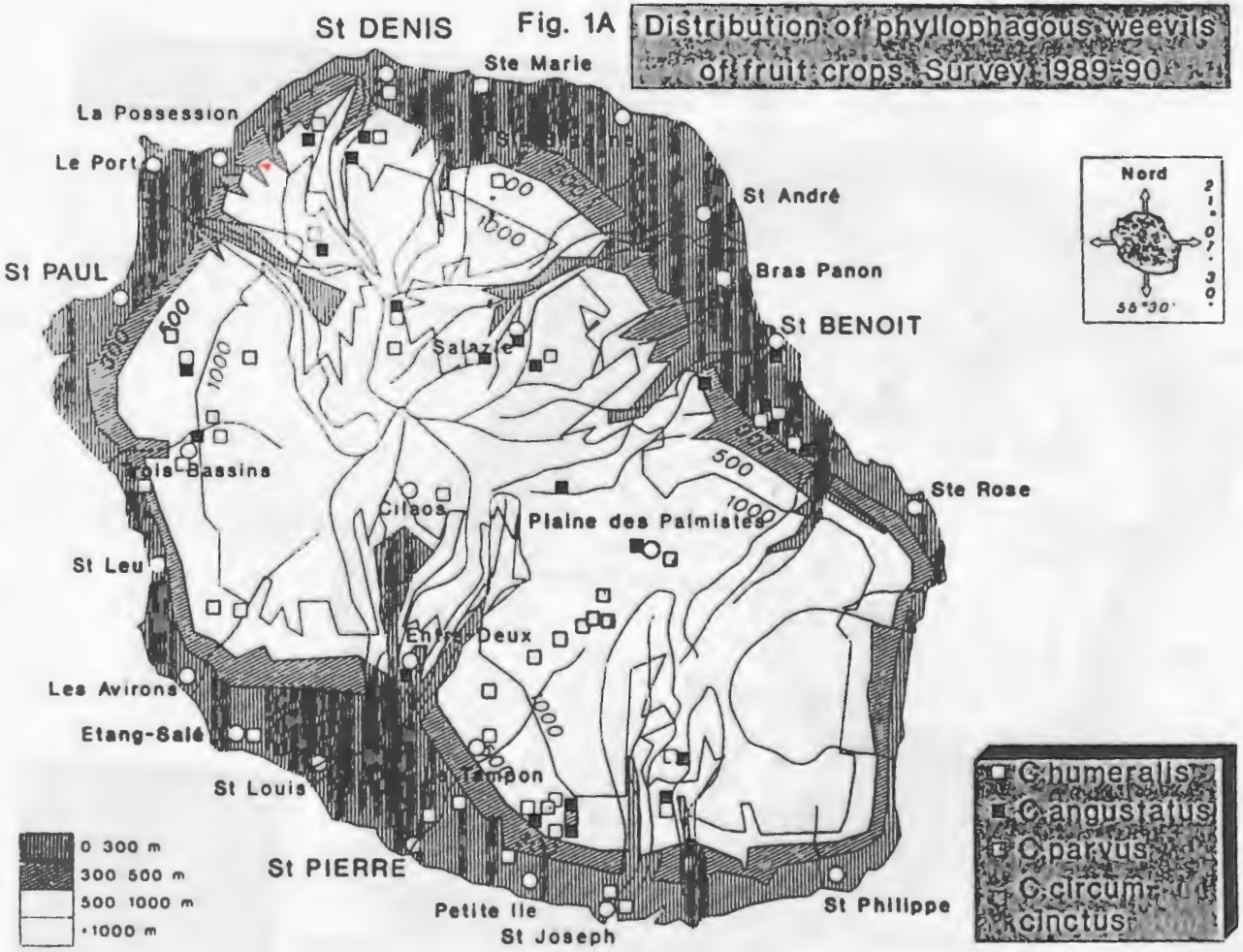

Fig. 1A Distribution of phyllophagous weevils of fruit crops. Survey 1989-90

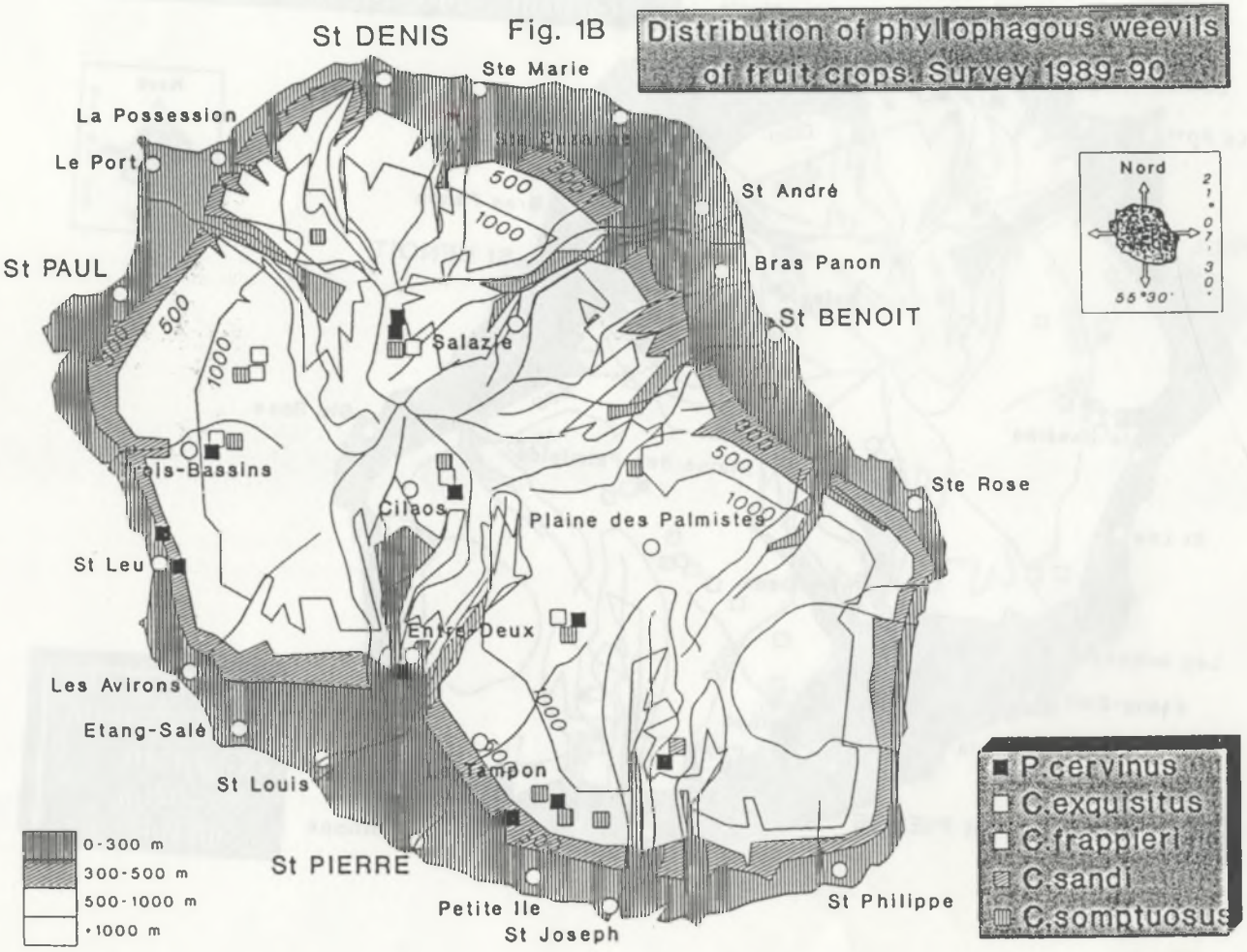
Fig. 1B
Distribution of phyllophagous weevils of fruit crops. Survey 1989-90
St DENIS
Ste Marie
La Possession
Le Port
St André
Bras Panon
St PAUL
St BENOIT
Salazie
Trois-Bassins
Cilaos
Plaine des Palmistes
Ste Rose
St Leu
Entre-Deux
Les Avirons
Etang-Salé
St Louis
Le Tampon
St PIERRE
Petite Ile
St Joseph
St Philippe
500
1000
300
Nord
21°07'30"
55°30'
0-300 m
300-500 m
500-1000 m
+1000 m
P.cervinus
C.exquisitus
C.frappieri
C.sandi
C.somptuosus

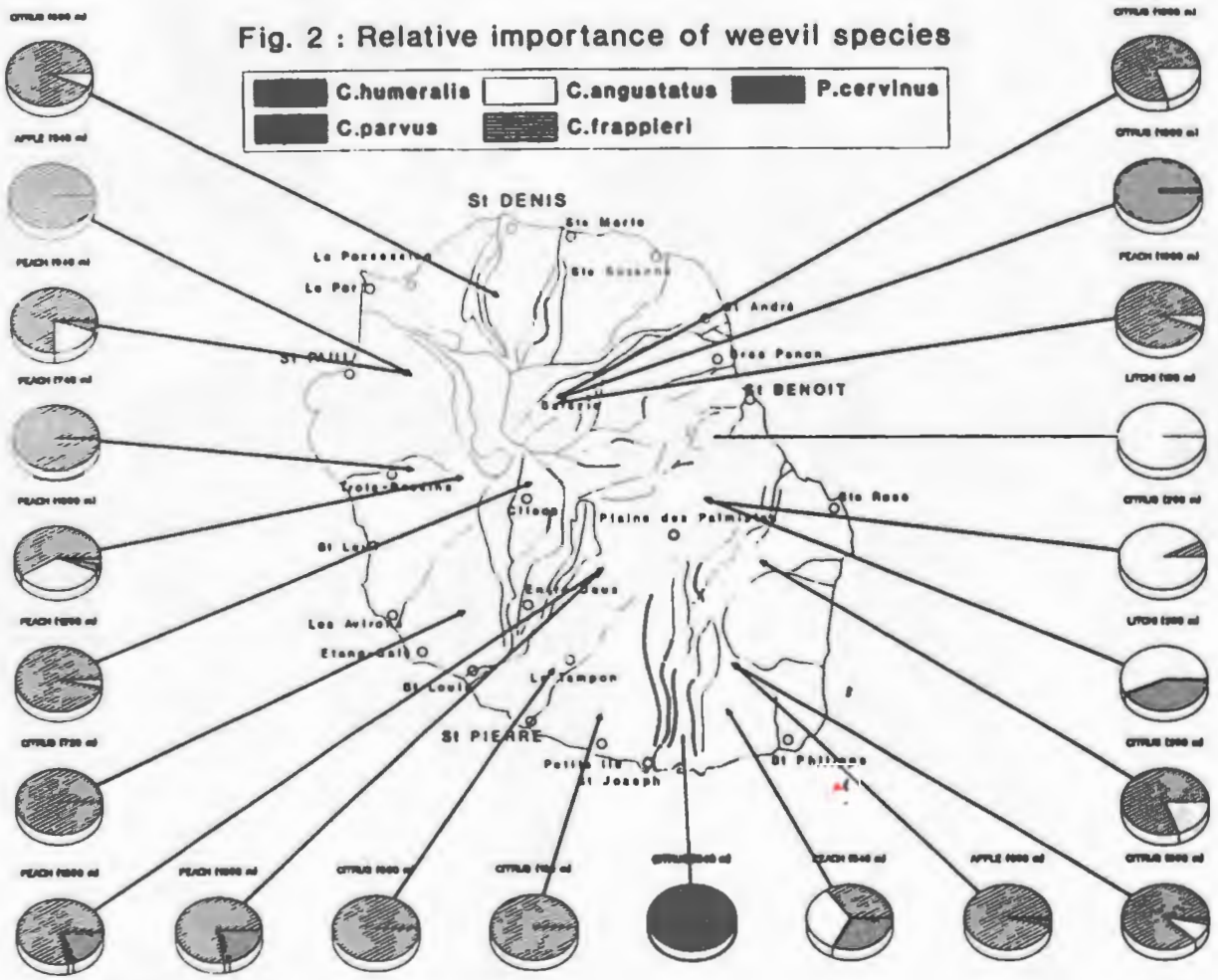
Fig. 2 : Relative importance of weevil species
C.humeralis
C.angustatus
P.cervinus
C.parvus
C.frappieri
St DENIS
Ste Marie
Ste Suzanne
La Possession
Le Port
St André
Bras Panon
St PAUL
St BENOIT
Trois-Bassins
Cilaos
Plaine des Palmistes
Ste Rose
St Leu
Les Avirons
Etang-Salé
St Louis
Le Tampon
St PIERRE
Petite Ile
St Joseph
St Philippe